Fachbereich Physik, Mathematik und Informatik

SFB TR49/ SFB TRR 173 Spin+X - Kolloquium -
Seminar experimentelle Physik der kondensierten Materie

Donnerstag, den 05.03.2020 um 14:00
im MAINZ Seminarraum, Staudinger Weg 9, 03-122

Prof. Thomas Allison

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Time-resolved ARPES at 88 MHz repetition rate with full 2π collection

Angle-resolved photoemission spectroscopy (ARPES) is often considered the best way to experimentally determine the ground-state electronic structure of materials. However, although applying ARPES to short-lived excited states via the pump/probe method (tr-ARPES) demands orders of magnitude more data than ground-state ARPES studies, measurements have been forced to work with orders of magnitude lower data rates due to the limits imposed by the repetition rate of available short-pulse extreme-ultraviolet (XUV) light sources and the collection efficiency of photoelectron analyzers. These limitations have severely restricted the range of samples and phenomena that can be studied with ultrafast tr-ARPES.

At Stony Brook, we have constructed a next-generation tr-ARPES instrument that addresses this data-rate challenge. We realize a high repetition rate ultrashort-pulse XUV light source using frequency comb methods and the technique of cavity-enhanced high harmonic generation CE-HHG. With a relatively simple and compact setup, the light source delivers to the sample $>10^{11}$ photons/s in well-isolated harmonics over a broad photon energy tuning range of 18-37 eV with a spot size of $58 \times 100\ \mu m^2$ [1-3]. The high repetition rate enables space-charge-free tr-ARPES experiments with nano-Ampere sample currents. From photoelectron spectroscopy data, we place conservative upper limits on the XUV pulse duration and photon-energy bandwidth of 93 fs and 65 meV, respectively. The light source has now been integrated with a time-of-flight momentum microscope [4] enabling efficient, parallel, momentum-resolved detection of the full 2π emission hemisphere from the surface under study.

I will discuss preliminary results with this new instrument, ongoing tr-ARPES experiments, and also continuing development of the instrument. In particular, I will focus on tr-ARPES measurements from micron-scale sample areas and tr-ARPES measurements with perturbative pump excitation to study the intrinsic quasi-particle dynamics of materials.

[1] X. L. Li et al., *Rev. Sci. Inst.* **87**, 093114 (2016). [2] C. Corder et al., *Structural Dynamics* **5**, 054301 (2018).
[3] C. Corder et al., Proc. SPIE 10519, LAMOM XXIII, 105190B (2018). [4] K. Medjanik et al., *Nat. Mater.* **16**, 615–621 (2017).

The guest is invited by Prof. Dr. G. Schönhense
Everybody interested is welcome!